REDEEMER
UNIVERSITY COLLEGE

the Armitt
Collection

Charlotte Mason's House of Education,
Scale How, Ambleside, UK, 2009

The **Charlotte Mason Digital Collection** is a not-for-profit database created in 2009-2011 to assist scholars, researchers, educators and students to discover, use, and build upon the Charlotte Mason Collection of archives, journals and books housed in the Armitt Library & Museum (UK). To learn more about this database or to search the digital collection, go to The Charlotte Mason Digital Collection.

Your use of images from the **Charlotte Mason Digital Collection** is subject to a License. To publish images for commercial purposes, a license fee must be submitted and permission received prior to publication. To publish or present images for non-profit purposes, the owner, Redeemer University College, must be notified at cmdc@redeemer.ca and submission of a copy of the context in which it was used also must be submitted to the owner at cmdc@redeemer.ca. Credit lines, as specified in the License, must accompany both the commercial and non-profit use of each image.

Unless you have obtained prior permission, you may not download an entire issue of a journal nor may you make multiple copies of any of the digital images. Higher resolution images are available. [Low resolution (150 dpi), single copy printing is permitted: High resolution images for publication can be purchased. Please contact Redeemer University College in writing as specified in the License to request high resolution images.

While the document originals are housed in the Armitt Library & Museum, Redeemer University College owns the rights to the Digital Images (in jpg/pdf format) of the original archival documents and artifacts. The original Digital Images and database metadata are owned and maintained by Redeemer University College. Multiple images are bound together in PDF Packages. Click here to download the latest version of Adobe Reader for better viewing. In the PDF, click an image thumbnail to view it.

This project was made possible through collaboration among the Armitt Library & Museum (Ambleside, UK), Redeemer University College (Ancaster, Canada) and the University of Cumbria (UK) and with the financial assistance of the Social Sciences and Humanities Research Council of Canada.

Need help? If you do **not** see a side-bar with image thumbnails:
Some of the PDF packages are large and will take some time to download. A very large PDF package may open more successfully if you download it first to your desktop. (From inside the database record, right-click on the link to the PDF package and save the link to your desktop.) Once it's on your desktop, you can open it up with a recent version of Adobe Reader.

If you have a Macintosh with Safari, the default program to open PDFs is Preview, which does not open the PDF packets. Mac users need to download Adobe Reader. If this cover page appears without a list of PDF files (either at the side or bottom of the screen), look for a paper clip or a menu option to view attachments. If you click that, you should see a list of the pages in the PDF package.

Viewing files with Linux: This works with the default PDF viewer that comes pre-installed with Ubuntu. While viewing this cover page in the PDF viewer, click "View" on the top toolbar, and check the box that says "Side Panel". That will bring up the side panel. The side panel will show only this cover page. Click the 'arrow' at the top of the side panel, and it will give you the option to view "attachments." If you click that, you should see a list of PDF files, which are the pages in the PDF package.

Social Sciences and Humanities
Research Council of Canada

Conseil de recherches en
sciences humaines du Canada

Canada

NATURE'S FLYING MACHINES.

By Rev. A. Thornley, M.A., F.E.S.

It has ever been man's dream to fly. At present he is almost the prisoner of one element; for his unaided efforts in the water, are after all, artificially acquired, and comparatively feeble. Yet, even here his inventions have helped him, and by means of steam and wind he has become possessed of much of the freedom of the ocean. But the machinery has not yet been invented which will enable him to fly. Will he ever attain to this most desirable and delightful art? It is, I think, possible. I read only a few weeks ago of a German professor* who had already made some progress in the æronautic art. By means of a pair of stupendous wings, and a considerable tail, he is able to soar away from an eminence some two or three hundred yards. But this is not true flight. He cannot flap his wings, he can only drop to the earth a little more gently than most people. However, I think he has begun at the right end of the study, in that he is learning to soar first. Now flight is a very complicated process, and it would be impossible to gain any real insight into the principles involved in it without some proper knowledge of both mechanics and animal anatomy. I will therefore, only now point out a few simple things which will be interesting to those of my readers, who have attained to some elementary knowledge of these subjects. The wing of a bird, and indeed of all flying animals, is a lever of the third system. The movable *Fulcrum* being the resistance formed by the air; the *Power*, the inherent muscular force; and the *Weight* to be moved, the body of the flying animal. It is, however, evident that a mere up and down motion

---

* "Nature," December 14th, 1893.

of the wings, besides supporting the weight of the creature, will only result in slight elevations and depressions of the body, we have yet to find out how they act as propellers. It has been shown on good evidence that the wings are in their action comparable to a screw, and the flying creature is urged through the air in much the same manner that a screw-launch is urged through the waters. But this subject is a large one, and difficult, and apparently yet under dispute. Perhaps one of the most accessible sources of information will be found in Prof. Pettigrew's book, "Animal Locomotion," published in the "International Scientific Series," where the reader will find quite an exhaustive account of flight in all its variations.

If, however, we are to learn anything practical about flight we must go to Nature, and watch and study her flying things, when we shall soon discover that she exhibits to us this power of flight in all gradations. Some creatures merely float for a few brief moments in the air, others on strong pinions cleave their way through the vast air ocean for hours together without weariness. We observe flight in its tentative beginning in flying Lemur, or Squirrel or Fish, to its marvellous perfection in soaring Eagle or Albatross. Any one who has watched a Squirrel or Marten making its way amongst the topmost branches of the trees of a wood, will have been astonished at the great leaps the little creature takes from bough to bough. Such progress is more like a kind of flying than ordinary quadrupedal motion, so that we are scarcely surprised to find that some members of this group of animals possess a singularly constructed flying membrane, working on the principle of the parachute. The strong skin of the body is extended at the sides into a large fold, which also swathes the limbs; the feet and hands alone being free. Some species of flying Squirrel have singular cartilaginous processes projecting from the wrist or elbow to help in the extension of this lateral flying membrane. In the "*Colugo*" or flying Lemur of Borneo (a member of the family to which our Hedgehog and Shrew belong) the lateral membranes are very extensive, and, indeed, the whole creature, save its extremities, is swathed in a most voluminous membrane, foreshadowing in this, as in other details, the structure of the

Bat. But the Colugo does not fly, it floats or rather glides through the air, the action being most graceful and the distance traversed astonishing. Dr. Wallace, F.R.S., to whom we owe so many interesting accounts of animals, tells us that after observing the flight of a Colugo from one tree to another, he paced the distance and found it about 70 yards, the amount of descent being only one foot in five. In this same group of Islands which the Colugo inhabits, are found the pretty flying Lizards (*Draco*). In these little creatures the parachute is formed in a different way. Some of the hinder pairs of ribs are greatly prolonged, projecting apparently through the sides of the body, and are covered with an extensible skin forming a kind of semi-circular wing. We are told it is a beautiful sight to behold these gorgeous little creatures darting about the foliage of a tropical forest, with their springy flight and glowing colours. It is an easy passage from Lizards to Fishes, and from these to the *Flying Fish* (*exocœtus*). *par excellence*, of which, it seems strange to say, that naturalists are not yet quite sure whether it flies or not. The large pectoral fins of this fish are not only very wing-like, but, we are informed by a competent observer, possess many of the minuter details of a true wing. Yet a considerable mass of evidence goes rather to show that these organs are not used quite like wings, the action being referable to the Kite rather than the pinion. If this be so it is somewhat surprising to learn that these fishes have been seen to travel some two hundred yards or more before re-entering their proper element, and to have attained an altitude of twenty feet above the sea's surface. It shows us that the leap from the water, by which the impetus is afforded, must be a very powerful one.

It is important we should now pause a moment, to notice that Nature often discharges the same function by means of very different organs, and yet at times different functions are performed by similar organs. I shall not now stop to give examples, as several will turn up in the course of this paper. It will suffice at present to say that organs which are structurally the same, whether performing the same functions or not, are usually termed *homologous;* but organs structurally different, yet performing the same functions are called *analagous*. Thus the wing of a bat and the arm of a man are homologous organs, but the wings of a butterfly and the wings of a bird are only analagous; that they are so will be fully shown later.

I will now show that the human arms or the fore limbs of any mammal or reptile or amphibian, are strictly homologous with the wings of a bat or a bird. The human arm in its skeletal simplicity consists essentially of one strong bone (*humerus*) attached at one end to the shoulder, and at the other to two smaller bones (*ulna* and *radius*), placed side by side, these are followed by a number of smaller bones constituting the palm of the hand, the wrist and the five fingers. This simple description, in lieu of a diagram, will sufficiently serve our purpose. In the Bat's wing all these bones will be found, though their several proportions are greatly altered. The most striking differences are observed in the enormously prolonged finger bones, the thumb alone being short. One of the two parallel bones succeeding to the wrist bone, the *radius*, is much elongated, and its companion bone, the *ulna*, reduced to almost a rudiment at the elbow. Over the elongate fingers, the strong elastic membrane of the wing is stretched, swathing most of the creature in its folds. It is to be noted that the thumb is free and armed with a claw. Likewise the toes are never elongated like the fingers, and being armed with sharp claws enable the creature to rest by hanging with its head downwards, whilst it clutches its perch with its feet.

In the *Pterodactyls*, a family of flying lizards, abundant during the Juvassic period of geology, an interesting variation on the structure of the bat occurs. Three fingers, and apparently a thumb of the hands were quite free, whilst the fourth or little finger was enormously elongated, to provide a support for the wing membrane which was probably similar to that of the bats. Some of these creatures, judging from the peculiarities of the skeleton, must have been very graceful; for the tail, in a few species, was greatly prolonged and furnished at the end with a leaf-like membrane, which probably acted as a rudder to steer them in their rapid flight. In size they varied greatly, some apparently not being much larger than a sparrow, whilst others rivalled the albatross in spread of wing.

But it is the bird's wing we know best of all. Is there any sound more delightful than the whirr of scores of wings when a flock of doves takes flight, with that marvellous unanimity so often observed, and turning and twisting in every direction makes sport of wind and weather? Or again it may be the sea birds sailing with their quiet, majestic grace over the bosom of the great deep. Perhaps to some it may have been given to mark the eagle's soaring flight amongst the clouds, or the mighty albatross roaming for days together over the face of the boundless ocean. To see such sights as these is to have our ideas of liberty and space—of matter and motion, greatly enlarged.

The bones of the bird's wing are not so very unlike those of the human arm and hand, save that the fingers are much atrophied, as usually there are only rudiments of three of these. But now a great difference from the wing of the bat or Pterodactyl presents itself. The resisting surface is made, not by membrane, but by those beautiful structures called plumes or feathers. Without a diagram it would be quite impossible to make the structure of these beautiful objects clear. But an observer should note how closely the feathers overlap one another, and yet they can be raised so as to allow of any quantity of air passing through them. Then again their lightness is wonderful, and their power of wear and tear also. As to their beautiful colours and elegant forms, it is impossible to do more than merely note it in passing, and suggest that much interest may be aroused by noting their arrangement in definite patches on the wings. Feathers are strictly homologous, with hairs and nails, though apparently so different in appearance, for in some birds, as in the Penguins, and in some members of the ostrich family, *e.g.*, the apteryx, they become very hair-like in their structure and appearance. Now it has been discovered that when a bird flies, it not only flaps its wings up and down, but it rotates them, causing them to describe in the air a figure of eight curve. It thus, as it were, screws itself along. Sometimes, as in "hovering," the motion of the wings is simply up and down.

There is one feature connected with flight, which is, however, very wonderful, and of which, no quite adequate explanation has yet been offered. I refer to the phenomenon known as "soaring." The great Albatross has been seen "sailing

and wheeling about" for an hour or more, without flapping its wings. In India, Cranes, Vultures and other large birds may be seen performing extensive gyrations in the air for long periods of time without any apparent motion of their wings. The common factor of a great variety of explanations seems to be that "any alterations in the direction or strength of an air current can be so utilized by birds as to enable them to soar." Perhaps some of my readers, with a little knowledge of mechanics, may be able to contribute something towards the solution of this problem of flight. Another question which has been frequently debated concerns the speed at which birds *ordinarily* fly. It is really very difficult to get trustworthy information on this head, yet opportunities for doing so may occur to many of my readers. Let it be remembered the information required is the rate of flight of a bird under ordinary circumstances, not when greatly frightened, or pursued by enemies. A little thought will show us that information of this precise kind is not easy to get. For instance a bird flying parallel to a moving train or carriage, the speed of which is known, may be observed for some short time, and in this way its speed calculated. But all experiments seem, in the nature of the case, to be of this indirect kind. One observer calculates the flight of the Turtle Dove at a little less than forty miles an hour, and another that of the Buffle-headed Duck (an American species), at about thirty-six miles per hour. Mr. Tegetmeier, a great authority on Homing Pigeons, estimates the rate of flight of these birds at from twenty-seven to forty-seven miles per hour, in, as I understand him, unfavourable weather. The greatest speed, therefore, of these birds must be much more. The Passenger Pigeon of the American States, must at times attain a high rate of flight, for it has been asserted that "the bird has frequently been killed in New York, with Carolina rice still undigested in its crop," "having probably accomplished a journey of between three and four hundred miles in about six hours, giving the high record of sixty miles an hour for six hours in succession." It would be equally interesting to know something about the speed of flight of our small birds, when fairly on the wing, but I have not been able to obtain any trustworthy information on this head.

It still remains for us to glance at another of Nature's contrivances for flight, viz., the wing of the insect. This organ though analagous to the wing of a bird is not at all homologous. Indeed it would be difficult to say what were its homologues. As a matter of observation it is a lateral expansion of the skin or epidermis of the thorax, traversed in several directions by veins, which are usually hollow chitinous tubes, and which are in every way analogous to the bones in the mammalian wing. The normal number of wings in the Insect family is four, but there are numerous exceptions. Thus the flies (*Diptera*) possess only two of these organs, the place of the hinder pair being marked by curious little structures called "balancers," which can be easily observed in the common Daddy-long-legs, or Crane Flies. In the Beetles (*Coleoptera*), the normal number are present, but the front pair are converted into hard chitinous organs, forming strong cases for the protection of the delicate hinder pair. In the family of Bugs (*Hemiptera*), the wings present an intermediate condition, as the front pair have their basal portion horny, the remainder, as well as the hinder pair, being transparent. The Dragon Flies (*Neuroptera*), have exceeding long and beautifully gauzy wings. In the Bees and Wasps (*Hymenoptera*), the wings vary a good deal, in some species being absent altogether, but more frequently (though present in the normal number) can be readily parted with. But it is in the large family of the butterflies and moths (*Lepidoptera*) that the Insect wing enters into its greatest perfection. As a rule these insects possess four large expansive wings, covered with beautiful scales, occasionally they are nearly or quite clear, and sometimes are atrophied or present in only a very imperfect condition in the female. The wings of the Lepidoptera are not only conspicuous for their variegated and beautiful colours but also for their varied and elegant outlines. It remains but to mention the vagaries of this organ in a curious little family, parasitical or wild bees and wasps, and considered to be closely allied to the Beetles (*Strepsiptera*). For a long time it was thought that the fore-wings in these tiny insects were entirely suppressed and only the hind wings developed, but it is now known that the fore-wings are very minute horny appendages, whilst the hinder pair are very greatly developed in the males. The females are grub-like and apterous. Even this brief survey will show that an insect might be placed in its family from a consideration of the wing alone. I have endeavoured to get some statistics about the speed of flight of insects, but have not been able to obtain any information which may be considered trustworthy. So we come to the end of a very brief review of Nature's Flying-machines. We see how flight is but one of the ways by which in the great struggle for existence, the creature seizes upon some of Nature's vacant spaces. To take possession of the land and water might seem an easy task compared with that of occupying the air. Yet the "children of life" have successfully accomplished this task. And if we look at the great families of living things, we shall be struck with the fact, that some members of almost all of them have developed this wonderful faculty of flight, and thus extended the domain of life. Nor is it less a cause of wonder, that the instrument by which flight is accomplished, is so greatly varied in structure. That there is yet much to be learnt, the numerous suggestions thrown out in this paper, will abundantly show; and much knowledge required, such for example, as the speed of flight of flying things of different kinds, might be obtained, with a little patient observation, without any great previous knowledge. May my readers help to this result.